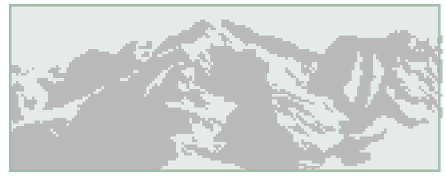
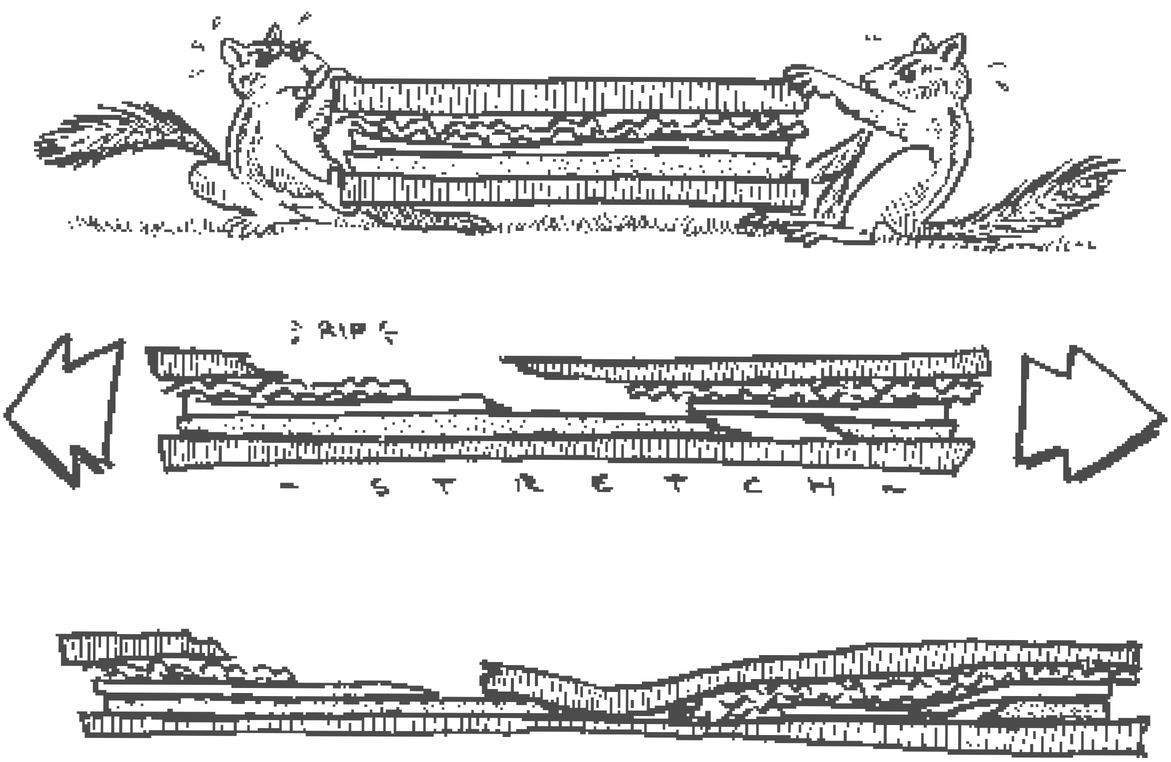
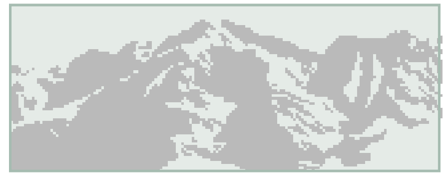


DYNAMIC GEOLOGY OF THE BASIN AND RANGE

Within the Basin and Range province, the earth's crust and upper mantle have been stretched up to twice their original width. The entire region has been subjected to extension, which thinned and cracked the crust as it was pulled apart, creating large faults. Along these roughly north-south trending faults, mountains were uplifted and valleys down-dropped, producing the distinctive alternating pattern of linear mountain ranges and valleys of the Basin and Range province.

Although there are other types of faults in the Basin and Range province, the extension and crustal stretching that shaped the present landscape produce mostly block faults. The upthrust side of these faults form mountains that rise abruptly and steeply, and the down-dropped side creates low valleys. The fault plane, along which the two sides of the fault move, extends deep into the crust, usually at an angle of 60 degrees. In places, the relief or vertical difference between the two sides is as much as 10,000 feet. When rocks are uplifted they are immediately subject to weathering and erosion. As mountains are weathered by water, ice, wind and other erosional agents, rock particles are stripped away and washed down the mountainside, often covering the fault plane. Sediment collects in the adjacent valleys, in some places burying the bedrock under thousands of feet of rock debris.





WHAT IS THE HYDROGRAPHIC GREAT BASIN?

The Basin and Range Geologic province's dynamic fault history has profoundly affected the region's water drainage system, or hydrology. Most precipitation in the Great Basin falls in the form of snow that melts in the spring. Rain that reaches the ground, or snow that melts, quickly evaporates in the dry desert environment. Some of the water that does not evaporate will sink into the ground and become ground water. The remaining water flows into streams and collects in short-lived lakes called playas on the valley floor and eventually evaporates or becomes groundwater. No streams, creeks, or rivers that originate within the Great Basin ever find an outlet to the ocean. The extent of internal drainage, the area in which surface water cannot reach the ocean, defines the geographic region known as the Great Basin.

The Great Basin's internal drainage results from blockage of water movement over high fault-created mountains and by lack of sufficient water flow to merge with larger drainages outside the Great Basin. This internally-drained area occupies approximately 200,000 square miles, including most of Nevada, a large part of Utah, and portions of Idaho, California, and Oregon. Most of the present-day Great Basin would drain to the sea - just as it did in the recent Ice Ages - if there were only more rain and snowfall.

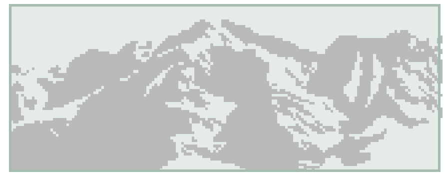
THERMAL SPRINGS IN THE GREAT BASIN

Approximately seven to twelve percent of the Great Basin's precipitation will become ground water. Even in the dry Great Basin, there are large amounts of water stored in the subsurface rock. The water seeps into the rocky underground "storage tanks" through porous soil or rocks and through fissures and faults. The thin, highly fractured crust produced by extensional stretching in the Basin and Range province enhances the circulation of fluids. A thin crust means that the earth's hot mantle is closer to the surface. In fact, the whole region has a higher heat flow than the surrounding areas. Cool fluids moving through the hot rock are heated and rise to the surface, forming thermal springs. The combination of geologic and hydrologic features of the region make the Great Basin an area with many thermal springs.

Safety note: Never enter or jump into a thermal spring before testing the water - they can be hot enough to kill a person.

NOTES:

GEOLOGY



GEOLOGIC HISTORY OF THE GREAT BASIN

For most of the Paleozoic Era, a shallow sea covered the region that is now the Great Basin. Sand, mud, and the skeletons of marine organisms accumulated on the bottom of the sea. The particles were compacted and cemented to form the sedimentary rocks, sandstone, shale, and fossiliferous limestone.

The western Great Basin was squeezed by several phases of compressional deformation and mountain-building during later Paleozoic and Early Mesozoic time. During these compressional phases, the crust was pushed from west to east and large sections of the crust rode eastward up and over adjacent sections. Mountain ranges grew and then eroded away, their sedimentary debris accumulating in surrounding areas. Two phases of compressional mountain-building occurred during the Jurassic and Cretaceous. The first phase affected a zone from southern California to Wyoming, cutting through eastern Nevada. Paleozoic sedimentary rock layers were stacked double-thick, forcing the lower layers deep into the crust where they were heated and deformed. Magma injected between the rock layers cooled to form granitic rocks. The second phase of compression in the Cretaceous created the ancestral Rocky Mountains.

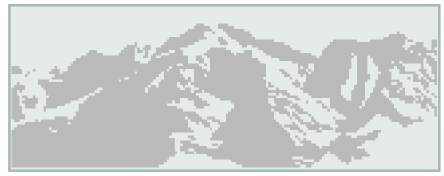
During the latter half of the Tertiary period of the Cenozoic era (about 40 to 20 million years ago), explosive volcanoes spread clouds of searing ash over thousands of square miles. About 20 million years ago, the Great Basin began to stretch east-west. The extensional forces created faults in the upper crust that led to the development of the modern Basin and Range landscape. The region continues to expand today.

During the Pleistocene epoch, glaciers formed in many of the higher mountains. This epoch has been marked by a series of glaciations, popularly known as “ice ages”, alternating with warmer periods similar to today’s climate. During the most recent glaciation, lakes flooded many valleys, plant communities shifted to warmer elevations and latitudes, and boreal mammals lived in the Great Basin.

*MYA stands for MILLIONS OF YEARS AGO.

GREAT BASIN TIME CHART

ERA	PERIOD	EPOCH	MYA
CENOZOIC	OUATERNARY *Q*	Recent	.01
		Pleistocene	2
	TERTIARY *T*	Pliocene	5
		Miocene	24
		Ogliocene	37
		Eocene	58
		Paleocene	66
MESOZOIC	CRETACEOUS *K*		144
	JURASSIC *J*		208
	TRIASSIC *TR*		245
PALEOZOIC	PERMIAN *P*		286
	PENNSYLVANIAN *IP*		330
	MISSISSIPPIAN *M*		360
	DEVONIAN *D*		408
	SILURIAN *S*		438
	ORDOVICIAN *O*		505
	CAMBRIAN *€*		570
PRECAMBRIAN *P€*			



EFFECTS OF THE ICE AGES

The climate of the Great Basin has not always been as it is today. From approximately 1.6 million to 10,000 years ago (the Pleistocene epoch) the earth's climate underwent four periods of cooling and glaciation separated by three warmer interglacial periods, similar to today's climate. The Pleistocene climate changes had a dramatic effect on the Great Basin. One result of the cooler climate was increased precipitation. At lower elevations the precipitation fell as rain; in the higher mountain ranges the precipitation fell as snow - the beginnings of glaciation. (If snow piles up faster than it melts, over the centuries it will eventually become thick enough to begin to slowly move downhill under the pressure of its own weight and an alpine glacier is born.) The higher mountains in the Great Basin were capped by glaciers during cooler Pleistocene periods.

Ice is a strong erosional force and much of the topography we see today in the higher mountain ranges is due to carving of rock by glacial erosion. Bowl-shaped mountain faces called cirques and U-shaped valleys cut by glaciers can be easily seen in the Snake Range, the Ruby Mountains, and other mountain ranges of Nevada. Piled up along the sides of U-shaped valleys and at the bases of cirques are moraines, large piles of boulders carried and deposited by glaciers. Today only one small alpine glacier remains in the Great Basin; it is located in the South Snake Range within Great Basin National Park.

Another type of glacier, a rock glacier, is also found in the glacier cirque of Great Basin National Park as well as in other high mountain ranges around the world. Rock glaciers are made up of angular rock fragments with ice filling the spaces between the blocks. Rock glaciers resemble alpine glaciers in outline and down-slope movement. By freezing, thawing, and sagging, the ice works with gravity to provide the force that moves the rock glacier.

During Pleistocene glacial periods, plant distribution was different from today. The plant communities were down-slope or south of their present locations. Limber pine and bristlecones, found only at high elevations near the timberline today, could be found on the sides of mountains.

At the end of the Pleistocene, Earth's climate began to warm timberlines on the sides of the mountains. Hundreds of feet of snow and ice from the high country began to melt. Large amounts of rain and snowmelt collected in the valley bottoms as lakes. Large rivers and lakes were common throughout the Great Basin during the Pleistocene. However, most of the lakes and rivers have evaporated in the present desert environment. The Great Salt Lake is a remnant of the largest Pleistocene lake - Lake Bonneville.

The pinyon-juniper community is an excellent example of how the changing climate has affected the distribution of plant communities. The pinyon-juniper community is the most common in the forested areas of the Great Basin. This community has been moving northward since the climate warmed and most of the ice melted in the Great Basin. Part of the explanation for this northward change in distribution is found by looking at bird distribution. Birds that disperse seeds of these trees have also been heading north and increasing their range since the last glaciers receded at the end of the Pleistocene. Plant and animal populations are always closely linked. Climate change affecting one will inevitably affect the other as well, as they are part of the same community.

NOTES:

CREATING YOUR OWN ROCK LEGEND

ACTIVITY 1

SUBJECTS:
Creative writing, spelling

LOCATION:
Classroom

DURATION:
20-30 minutes

OBJECTIVE:
Students will use their imaginations to create a personal story based upon facts offered in class.

KEY VOCABULARY:
Legend, myth, story, minerals, geology

MATERIALS:
Pen, pencil, paper

METHOD:
1) Read the Goshute Legend to the class (possibly more than once).
2) Discuss what it could mean; do all stories have “meaning or a moral”? What is the difference between a story, a myth, or a legend?
3) Instruct the class to write their own story or myth about rocks and geology in their area. Use imagination! Encourage them to come up with wild stories based on the facts. If the students haven’t yet learned the “real” story about the Great Basin, then this will be their opportunity to create their own story!

ADAPTATION:
This exercise can be adapted for younger children in kindergarten through grade 3. Ask the students to create and write (or verbally contribute) sentences. String the sentences together and have the entire class create a story.

“CREATION OF BASIN AND RANGE” (GOSHUTE LEGEND)

The Goshute have a legend describing how the basins and ranges of the Great Basin were formed:

“In the beginning, all the area in eastern Nevada was one large mountain. One day Hawk and Coyote met on this large mountain. They began to quarrel. The two animals became very angry. Soon Hawk soared high into the air. Hawk then dove down to the mountain and began ripping it apart with its claws. When Hawk finished, many ranges and basins had been created, including the Snake Range and Wheeler Peak.”

DEEP TIME

ACTIVITY 2

SUBJECTS:
Art, math, science

LOCATION:
Classroom

DURATION:
30-45 minutes

OBJECTIVE:
Demonstrate the relative distance of events in time.

KEY VOCABULARY:
Time, history, human history

MATERIALS:
Adding machine paper tape (at least 40 feet), crayons, Span of Time chart (see following page)

METHOD:
1) Find a space about 40 feet in length.
2) Assign one student to represent the beginning of the Earth and have them pull out the paper tape. Lay the tape on the floor.
3) Assign each student an event on the Span of Time chart and have him/her pace out the distance to his/her assigned event.
4) Starting out with the beginning of the Earth, have each student call out his/her event and how long ago it occurred.
5) Have each student draw a picture to represent his/her assigned event at the length of tape that represents that date in time. (Note that modern events have occurred in such a tiny part of recent history, compared with the rest of time, that it would be difficult to include all those events on the tape).

EXTENSIONS:
Try a larger format outdoors, using twine instead of paper tape. Using the same format, make a time line for human history.
For a math exercise, try converting the chart to metric or practice measuring in metric.

NOTES:

THE SPAN OF TIME

LENGTH OF TIME FROM PRESENT (INDOOR)	LENGTH OF TIME FROM PRESENT (OUTDOOR)	YEARS AGO	EVENT
38 FEET	254 YARDS	4.57 BILLION	EARTH BEGINS
29 FEET	194 YARDS	3.5 BILLION	LIFE ON EARTH BEGINS
25 FEET	167 YARDS	3 BILLION	FIRST FOSSILS FORM: ALGAE, FUNGI, BACTERIA ABUNDANT
4.5 FEET	31 YARDS	550 MILLION	JELLYFISH, SPONGES WORMS ABUNDANT
3.75 FEET	25 YARDS	450 MILLION	FIRST PRIMITIVE FISH
40 INCHES	22 YARDS	400 MILLION	EARLIEST LAND PLANTS (FERNS AND MOSSES)
35 INCHES	19 YARDS	350 MILLION	EARLIEST LAND ANIMALS (AMPHIBIANS)
31 INCHES	17 YARDS	310 MILLION	FIRST REPTILES
27 INCHES	15 YARDS	270 MILLION	REPTILES ABUNDANT (AS WELL AS DEVELOPED)
24.5 INCHES	14 YARDS	245 MILLION	AGE OF DINOSAURS BEGINS
18 INCHES	10 YARDS	180 MILLION	FLOWERING PLANTS DEVELOP
16 INCHES	9 YARDS	160 MILLION	BIRDS EVOLVE DINOSAURS ABOUND
7 INCHES	4 YARDS	70 MILLION	MODERN BIRDS DEVELOP
6 INCHES	11 FEET	65 MILLION	DINOSAURS EXTINCT AGE OF MAMMALS BEGINS
5 INCHES	8 FEET	50 MILLION	MAMMALS AND BIRDS ABUNDANT
4 INCHES	7 FEET	40 MILLION	FIRST ELEPHANTS
.5 INCHES	10 INCHES	5 MILLION	FIRST HUMANS
.15 INCHES	3 INCHES	1.5 MILLION	BEGINNING OF PLEISTOCENE AND ICE AGES
.001 INCH	.02 INCH	10,000	END OF MOST RECENT ICE AGE
.0002 INCH	.004 INCH	1,915	MT. VESUVIUS ERUPTS IN POMPEII
.0001 INCH	.0015 INCH	779	MAGNA CARTA SIGNED IN 1215
.00002 INCH	.0004 INCH	225	DECLARATION OF INDEPENCE SIGNED IN 1776

SCALE

INDOOR: 0.1 INCH=1 MILLION YEARS **OUTDOOR: 2 INCHES=1 MILLION YEARS**

GREAT BASIN POETRY

ACTIVITY 3

SUBJECTS:
Creative writing, art, geology

LOCATION:
Classroom

DURATION:
30-45 minutes

OBJECTIVE:
Students will be able to visualize the Great Basin and its basin and range topography. They will create original art and poems reflecting their knowledge.

BACKGROUND: See paragraph on the Dynamic Geology of the Basin and Range (Page 1 of this chapter).

KEY VOCABULARY:
Basin and Range, Great Basin

MATERIALS:
Paper, pen or pencil, and drawing materials

METHOD:
1) Have the students each write a poem about the Great Basin or its basin and range topography.
2) Have the students each create a "picture poem" with their written poem (i.e. the students write the words of their poem in a drawing that depicts the Great Basin or basin and range topography to them.
3) Have the students illustrate their poems with other Great Basin and basin and range scenery such as plants, earth forms, and animals.

The Great Basin goes up and down basin and range basin and range basin and range basin

basin and range basin and range basin and range basin and range basin and range basin

basin and range basin and range basin and range basin and range basin and range basin

basin and range basin and range basin and range basin and range basin and range basin

ACTIVITY 4

SUBJECT:
Geology

DURATION:
1-2 hours (not including prep time). You may choose to include the students in preparation as well, and you should set aside time over several days to do this. The formation of glaciers is a long process, so spreading the activity out over time may give students a better appreciation of this.

KEY VOCABULARY:
Moraine (terminal and lateral)

MATERIALS:
Half gallon milk carton, 12 foot long by 1 foot wide panel or board, sand, rocks, and gravel.

OBJECTIVE:
Students will be able to describe how a glacier carves an area and its characteristic appearance.

METHOD:
1) Remove one side panel from the half-gallon milk carton.
2) Fill 1/3 of the milk carton with rocks, sand and gravel mixed with water. Freeze it. When frozen...
3) Fill the second 1/3 of the milk carton with more rocks, sand and gravel mixed with water. Again, freeze it. When frozen...
4) Fill the final 1/3 of the carton with rocks, sand, and gravel mixed with water. Freeze the carton completely.
5) On a day when the temperature is above 55 degrees, lay out the 12-foot wood panel. Set the panel at a 20 degree angle.
6) Spread gravel approximately 1 inch thick on the top of the panel.
7) Remove the frozen block from the milk carton.
8) Lay the block of ice, rocks and gravel at the top of the panel.
9) After approximately an hour, observe the movement of the block and the resulting carving of the gravel surface on the wood panel.

EXTENSION:
Make more than one ”glacier”. Try the above exercise on a cool day and again on a hot day - is there any difference in how it moves? What about how quickly it melts? Discuss with the students how climate change maybe affecting present day glaciers.

Adapted from “Snappy Props” by Smitty Parrot